JOINT INVENTORS

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APPLICATION FOR UNITED STATES LETTERS PATENT SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

Be it known that we, Colin G. CARO, a citizen of Great Britain, residing c/o Imperial College of Science Technology & Medicine, Exhibition Road, London SW7 2AZ, Great Britain; David D.A. PIESOLD, a citizen of Great Britain, residing c/o Knight Piésold & Partners, Kanthack House, Station Road, Ashford, Kent TN23 1PP, Great Britain; and William TALLIS, a citizen of Great Britain, residing c/o Major Contractors Group, 56-54 Leonard Street, London EC2A 4JX, Great Britain, have invented new and useful PIPES FOR STEAM POWER-PLANT, of which the following is a specification.

PIPES FOR STEAM POWER-PLANT

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation of Attorney Docket No. 30675/39744 filed November 17, 2003, which is the U.S. national phase of International Application No. PCT/GB02/02339.

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to turbines, and more particularly to turbines for use in the generation of electricity.

Related Technology

Most generators used to produce electricity are driven by steam turbines. The turbines themselves are driven by steam produced in boilers heated by fossil fuels or by a nuclear reactor. It will normally not be possible to have a straight pipe leading from the outlet of the boiler to the inlet of the turbine, and so the pipework will generally consist of a number of lengths of straight pipe connected by bends, such as elbow bends.

Pipe fittings such as elbow bends normally cause head loss in the fluid flowing in the pipe. The head loss caused by fittings can be reduced by modification of the fittings; for example, the sweep of an elbow bend can be increased. However, it may not be possible to use elbow bends with a large sweep in the confines of a power generation plant. Further, there is still the problem that the mere presence of fittings of this type will contribute to head loss, and it will be appreciated that any amount of head loss, however small, can have a large effect on the total costs of generating electricity over the lifetime of a generation plant.

According to a first aspect of the invention, there is provided a turbine for use in electricity generation, including pipework for gas or vapor entering or leaving the turbine,

wherein the pipework comprises at least one substantially rigid pipe, having at least one section with a centerline curving in three dimensions.

BRIEF DESCRIPTION OF THE DRAWINGS

The sole figure is a schematic perspective view of a boiler B, a turbine T and a condenser C.

DETAILED DESCRIPTION

In a normal elbow bend, in which the centerline of the pipe curves in two dimensions, the pressure at the inside of the curve is reduced in comparison to that at the outside of the curve. There is a resultant tendency for flow to separate from the inner wall of the curve, leading to energy losses caused by eddying turbulence. The flow separation may also result in cavitation at the inner wall, which can damage the pipe and reduce its useful working life.

However, in a tubular portion the centerline of which curves in three dimensions, swirl flow tends to develop. Under these circumstances, the axial velocity profile of the flow across the tubular portion becomes more uniform or "blunter", with the speed of flow at the outside of the curve being less than it would be in similar flow in a two-dimensional curved pipe, and the speed at the inside being greater. Thus, the near wall velocity profile around the tubular portion tends to be circumferentially more uniform with its non-planar geometry than it would be with planar geometry (in a normal elbow bend) Since the velocity profile of the flow is more uniform, there is a reduced tendency for separation to occur at the inner wall of the curve, and this leads to reduced energy losses caused by eddying turbulence, and reduced risk of cavitation.

The reduction of the pressure drop which can be achieved using pipes having a centerline curving in three dimensions rather than elbow bends can be of significant economic importance with regard to turbines used for the generation of electricity.

In a preferred form, the turbine is a steam turbine, and the pipework is positioned between a boiler and the turbine. The reduction in pressure drop between the boiler and the turbine enables the steam to enter the turbine at a higher pressure, which can lead to higher efficiencies.

In a further preferred form, the turbine is a steam turbine, and the pipework is positioned between the exit of the turbine and a condenser.

The invention also extends to pipework for use with turbines as described above.

Pipes having a centerline curving in three dimensions can, for example, be used in the pipework carrying the exit steam from a condensing steam turbine in an electricity generation process. The steam is reduced to below atmospheric pressure so that as much of the energy in the steam as possible is extracted torn electricity generation. Pipes having a centerline curving in three dimensions allow the pressure drop between the steam turbine exit and the condenser to be lowered, and this in turn allows the economic extraction of even more energy, thus improving the efficiency of the electrical generation process.

Such pipes can also be employed in the pipework conveying low pressure steam or other gases to an exhaust steam or gas turbine to generate electricity and in the exit pipework from such a turbine In addition, the reduction in head loss achieved by using such pipes can be advantageously applied to other aspects of steam or gas turbines.

Referring to the drawings figure, the boiler B is connected to the turbine T by a pipe 10, and the turbine is in turn connected to the condenser C by a pipe 20. High-pressure steam flows from the boiler B to the inlet of the turbine T through the pipe 10, and low-pressure steam is exhausted from the turbine T to the condenser C.

The pipes 10 and 20 have centerlines which curve in three dimensions. This induces swirl flow in the pipes as described above, which serves to reduce pressure loss in the steam, thus improving the overall efficiency.